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ABSTRACT

U.S. House of Representative members requested that the General Accounting Office determine what federal and state actions have been taken in addressing indoor air quality (IAQ) concerns raised in certain school, state, and federal buildings within Vermont, Maryland, and the District of Columbia. This report responds to this request and describes the investigation process, the level of federal agency involvement, and the role of Vermont officials in addressing IAQ problems. The report indicates that Vermont has already conducted investigations of 8 of the 15 buildings selected for review and is actively pursuing IAQ improvements in all its state buildings. State actions in resolving the most frequently noted IAQ complaints have mostly come through improvements in better air ventilation and cleaning and maintenance procedures. The Environmental Protection Agency (EPA) is assisting Vermont officials in some IAQ testing and is providing guidance and sponsoring workshops. The agency has addressed IAQ problems at the two federal buildings selected for review, including extensive physical improvements in its Washington, D.C., headquarters buildings. Similar improvements have been made at the General Services Administration(GSA) office building in Baltimore, Maryland. Additionally, the EPA and GSA have increased the availability of medical services at each of these buildings to assist occupants with IAQ-related problems. (GR)

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ED 425 621

B-279615

May 1, 1998

The Honorable Bernard Sanders
The Honorable Elijah E. Cummings
The Honorable Henry A. Waxman
House of Representatives

Subject: Indoor Air Quality: Federal and State Actions to Address the Indoor Air Quality Problems of Selected Buildings

In recent decades, particularly since the energy crisis of the 1970s, exposure to indoor air pollutants is believed to have increased in buildings. This increase in pollutants, such as carbon dioxide, molds, particulates, and volatile organic chemicals, is due to a variety of factors, including the construction of more tightly sealed buildings and the reduction of ventilation rates to cut energy costs, the increased use of synthetic building materials and furnishings, and the increased use of chemically formulated personal care products, pesticides, and housekeeping supplies. While indoor air pollution can be a matter of concern in all types of buildings, it is of particular concern in large buildings, such as office buildings and schools. In large buildings, people typically have much less control over their environment than they do in their own homes. In addition, office buildings and schools may have significant sources of air pollution that are unique to them (such as printing and copying devices, interior parking garages, laboratories, and vocational training shops), may be overcrowded and poorly maintained, and may have ventilation systems that are not designed or operated to provide adequate amounts of fresh air. (See enc. I for background information on indoor air quality issues.)

Because of your concerns about the quality of indoor air, you asked us to provide information on the federal and state actions that have been taken to address indoor air quality concerns that have been raised by occupants of certain school, state, and federal buildings in Vermont, the District of Columbia, and Maryland. Specifically, you asked that we (1) determine the extent to which the Environmental Protection Agency (EPA) and other federal agencies have been involved in investigating, evaluating, and mitigating the indoor air problems of 15 specified buildings in Vermont and, if there has been little or no direct federal involvement, identify the reasons and other forms of federal

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assistance, if any, that have been provided; (2) discuss the role of the nonfederal organizations that have acted to address the indoor air quality problems of the buildings; (3) describe the indoor air quality problems in these buildings and the steps that have been taken or that are needed to deal with them; and (4) provide information on the actions taken by federal agencies to address air quality problems in EPA's headquarters buildings at Waterside Mall in Washington, D.C., and in the Fallon Federal Office Building in Baltimore, Maryland.

RESULTS IN BRIEF

Federal agencies generally did not investigate, evaluate, or mitigate indoor air quality problems in the 15 Vermont buildings included in our review. While a number of federal agencies, including EPA, the Occupational Safety and Health Administration, and the National Institute for Occupational Safety and Health, share a role in addressing the problem of indoor air pollution and promoting good indoor air quality, the federal role currently is largely confined to one of research and information dissemination. Although the Occupational Safety and Health Administration has extensive enforcement authority and is working on a proposed indoor air quality standard, its policy is to handle most indoor air quality complaints informally by letter. The Vermont Department of Labor and Industry, under a state plan approved by the Occupational Safety and Health Administration, is responsible for most workplace enforcement in the state, including coverage of state and local government workplaces. The agency has conducted inspections in response to indoor air quality complaints in 8 of the 15 buildings included in our review and has been active on a committee to improve the indoor air quality in state buildings. EPA and the National Institute for Occupational Safety and Health do not have regulatory authorities to ensure the quality of indoor air and have not been given the resources necessary to comprehensively address indoor air quality problems in nonfederal buildings. Nonetheless, EPA has assisted Vermont officials in testing for air pollutants at 3 of the 15 buildings, and the National Institute for Occupational Safety and Health has performed field investigations of possible health hazards at another 2 of the buildings included in our review. In addition, EPA has also made contributions to improving indoor air quality in Vermont by sponsoring workshops, providing guidance, and performing other informational activities. (See enc. II for details on the activities of federal agencies regarding indoor air complaints in Vermont.)

In the absence of federal regulatory authority and the resources for addressing indoor air quality in nonfederal buildings, the investigation, the evaluation, and the remediation of air quality problems are essentially state, local, or private

responsibilities. In Vermont, state government agencies, local school administrations, and private consultants have been most directly involved in addressing the indoor air quality problems of the Vermont public schools and government office buildings that were included in our review. With minor exceptions, the costs of investigating indoor air quality complaints, evaluating indoor environmental conditions, and taking steps to remedy the problems discovered in these buildings have been borne by state and local authorities. While there is no single established procedure in Vermont for filing complaints about suspected indoor air problems and for obtaining assistance in dealing with these problems, several options are available to those who have concerns about the healthfulness of the air in their schools and office workplaces. (See enc. III for details on the actions taken by Vermont agencies and on the various organizations to which building occupants may address their concerns about indoor air quality.)

The most frequently noted complaints of occupants of the buildings included in our review involved breathing difficulties, dizziness, headaches, and eye and throat irritation. Although serious illnesses generally have not resulted from problems at the buildings, in several cases, workers or students have required treatment at hospitals, have been unable to return to work or school, and have continued to experience health problems, not all of which could be conclusively attributed to a building's air quality. Inspections and/or air quality tests performed at the buildings generally identified one or more of the following problems: inadequacies in the heating, air-conditioning, and ventilation system, the presence of molds or other biological growths caused by water infiltration, and volatile chemical emissions from newly installed carpeting or furnishings. Actions taken or needed to correct such problems include increasing air flow and fresh air intake and establishing better cleaning and maintenance procedures in the buildings. (See enc. IV for details on the indoor air problems in Vermont buildings and the corrective actions taken.)

At the two federal office buildings included in our review, federal agencies have taken a number of actions to address indoor air quality problems. EPA has made extensive physical improvements to its Washington, D.C., headquarters buildings; and the General Services Administration (GSA) has made similar improvements at the Fallon Federal Office Building in Baltimore, Maryland. In addition, EPA and GSA have increased the availability of medical services at each of these buildings to assist workers experiencing symptoms associated with indoor air quality problems. (See enc. V for details on the indoor air problems at these federal buildings and the corrective actions that have been taken.)

AGENCY COMMENTS

We provided copies of a draft of this report for review and comment to the four federal agencies and the four Vermont agencies whose indoor air-related activities we examined in connection with the specific sick buildings we were asked to review. These agencies are EPA, the Occupational Safety and Health Administration, the National Institute for Occupational Safety and Health, GSA, and the Vermont departments of Health, Labor and Industry, State Buildings and General Services, and Education. In general, the agencies agreed with the facts presented in the report and provided comments primarily of a technical and editorial nature, which we incorporated in the report, as appropriate. EPA expressed its appreciation for the report's fairness and accuracy and its explicit recognition that despite the health threat posed by indoor air pollution, neither it nor the National Institute for Occupational Safety and Health has been granted regulatory authority to help ensure the quality of indoor air, nor has either been given the resources necessary to comprehensively address air quality problems in nonfederal buildings. The Commissioner of the Vermont Department of Health noted that while the report contains numerous mentions of federal agencies that share a role in disseminating information and research related to indoor air pollution, it would greatly help state departments if federal assistance went beyond these activities and "assisted in standard setting, technical assistance, and resources in the form of state grants."

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In performing our work, we interviewed headquarters and regional officials of various federal agencies that prior GAO work has shown have some role in addressing the problems of indoor air pollution. These agencies included EPA, the Occupational Safety and Health Administration, the National Institute for Occupational Safety and Health Administration, and GSA. We examined the statutory authority, the rules, and the internal guidance of these agencies that relate to their roles and responsibilities for addressing indoor air pollution problems. We interviewed officials of various Vermont agencies, including the departments of Health, Labor and Industry, State Buildings and General Services, and Education. In addition, we interviewed officials of EPA and GSA who were responsible for directing and coordinating agency responses to the indoor air pollution problems of EPA's headquarters buildings and the Fallon Federal Office Building. We also obtained and reviewed extensive federal and state agency documentation relating to the investigation, the evaluation, and the mitigation of the indoor air quality problems in the buildings we reviewed. Our work was performed from December 1997 through April 1998 in accordance with generally accepted government auditing standards.

As agreed with your offices, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of this letter. At that time, we will send copies to the Secretary of Labor; the Secretary of Health and Human Services; the Administrator, Environmental Protection Agency; the Administrator, General Services Administration; the commissioners of the Vermont departments of Health, Labor and Industry, State Buildings and General Services, and Education; and other interested parties. We will also make copies available upon request.

Please call me at (202) 512-4907 if your or your staff have any questions. Major contributors to this report were Ed Kratzer, Ralph L. Lowry, and Larry D. Turman.

Peter F. Guerrero
Director, Environmental
Protection issues

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BACKGROUND

Studies of human exposure to chemical and other air pollutants indicate that indoor air levels of many pollutants may be 2 to 5 times, and occasionally more than 100 times, higher than outdoor levels. These levels of indoor air pollutants are of concern because, according to EPA's estimates, most people spend as much as 90 percent of their time indoors. Moreover, shifts in the national economy, particularly the growth of the information processing and service sectors and the relative decline of blue collar employment, mean that each year more and more people are joining the ranks of those who spend the major part of their lives indoors. In recent years, comparative risk studies performed by the Environmental Protection Agency (EPA), its Science Advisory Board, and others have consistently ranked indoor air pollution (including secondhand smoke, radon, organic compounds, and biological pollutants) among the top five environmental risks to public health. EPA and others have estimated the costs of indoor air pollution in the tens of billions of dollars per year. These economic costs include direct medical costs for people whose health is affected by poor indoor air quality (IAQ) and who receive treatment, lost productivity from absences due to illness, decreased efficiency on the job, and damage to materials and equipment from exposure to indoor air pollutants.

EPA and other experts believe that over the past several decades, particularly since the energy crisis of the 1970s, our exposure to indoor air pollutants has increased. This is due to a variety of factors, including the construction of more tightly sealed (energy efficient) buildings; the reduction in ventilation rates to cut energy costs; the increased use of synthetic building materials and furnishings; and the use of chemically formulated personal care products, pesticides, and housekeeping supplies. While indoor air pollution can be a matter of concern in all types of buildings, including houses and apartments, it is of particular concern in office buildings and in other large buildings, such as schools.[1] In such buildings people typically have less control over the indoor environment than they do in their own homes. For example, they typically lack the ability to open a window, adjust the temperature and humidity controls, control the overall level of cleanliness, or regulate the use of chemical products by others. Additionally, office buildings and schools may have significant sources of air pollution that are unique to them, such as printing and copying devices, interior parking garages, laboratories, and vocational

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[1]According to EPA, indoor air quality is of no less concern in residences. In fact, EPA reports that, for most people, the residential environment provides the most significant exposures to two very important pollutants, environmental tobacco smoke and radon. Furthermore, studies have shown high exposures to volatile organic compounds and particulate matter in residences. In addition, residential environments contribute much of the exposure of children to such biological contaminants such as mold, mildew, and cockroach and dust mite allergens, which are important contributors to asthma.

training shops. They also may be overcrowded and poorly maintained, and their mechanical ventilation systems may not be designed or operated to provide adequate amounts of fresh air. In the opinion of some World Health Organization (WHO) experts, up to 30 percent of new or remodeled commercial buildings may have unusually high rates of health and comfort complaints from occupants that may potentially be related to IAQ.[2]

Indoor air pollution in schools is of special concern for several reasons, particularly because children may be especially susceptible to the health effects of such pollution. The same concentration of pollutants can result in more pronounced effects on the bodies of children than on adults because children breathe a greater volume of air relative to their body weight. In schools, moreover, occupants are close together, with the typical school having approximately four times as many occupants as office buildings for the same amount of floor space. Such high occupancy levels place heavy demands on often outmoded, poorly designed, and inadequately maintained heating, ventilation, and air-conditioning (HVAC) systems and strain the ability of budget-constrained school administrators to maintain the hygienic and other interior environmental conditions conducive to good IAQ. GAO has reported that over half of the nation's schools have unsatisfactory indoor environmental conditions, including inadequate ventilation and poor air quality, that present a health threat to students and staff.[3] HVAC systems were the most frequently reported building feature in need of repairs in these schools.

The federal government's role in ensuring good air quality in the nation's homes, schools, and other public buildings has been a limited one since the issue of indoor air pollution first achieved prominence in the late 1970s and early 1980s. To date, the Congress has not assigned to EPA or any other federal agency a comprehensive regulatory mandate for indoor air. While a number of federal agencies, most importantly EPA and the National Institute for Occupational Safety and Health (NIOSH), currently share a role in addressing the problem of indoor air pollution and promoting good IAQ, that role remains largely confined to one of research and information dissemination, including technical assistance and outreach. Moreover, the levels of these activities have

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[2]Indoor Air: Evaluations and Conclusions for Health Sciences and Technology (Swedish Council for Building Research, Stockholm, Sweden, 1986). This report contains a chapter on "The Sick Building Syndrome" that reflects the deliberations of a subgroup of the WHO Regional Office for Europe Working Group on Indoor Air Research, which met in Stockholm August 27-31, 1984.

[3]School Facilities: Conditions of America's Schools (GAO/HEHS-95-61, Feb. 1, 1995). See also School Facilities: America's Schools Report Differing Conditions (GAO/HEHS-96-103, June 14, 1996) and School Facilities: Profiles of School Condition by State (GAO/HEHS-96-148, June 24, 1996).

been constrained, particularly in recent years, by tight budgets. For fiscal year 1998, EPA received $30.3 million for its indoor air program. This amount included funding for program management, research, and grants to address such issues as radon and environmental tobacco smoke. This funding represents less than one half of one percent of EPA's total budget of $7.4 billion for that year and supports a combined headquarters and field staffing level of approximately 150 full time equivalents (FTE). This staffing level is less than one percent of the 18,283 FTEs supported agencywide by EPA's total budget for fiscal year 1998.

Another reason for the limited federal role in this area is that air quality standards specifically for the nonindustrial indoor environment do not currently exist. NIOSH, the Occupational Safety and Health Administration (OSHA), and the American Conference of Governmental Industrial Hygienists (ACGIH) have published or proposed standards or recommended limits for industrial exposures. However, with few exceptions, industrial and nonindustrial environments are not comparable in terms of types and levels of exposures and available controls, and the concentrations of pollutants observed in nonindustrial indoor environments typically fall well below the published occupational standards or recommended exposure limits. In 1994, however, pursuant to its authority under its basic statute to ensure safe and healthful conditions in the workplace, OSHA proposed regulations governing IAQ in the nonindustrial work environment that were based on the research findings of NIOSH, EPA, and others. These proposed regulations, which included significant restrictions on environmental tobacco smoke, proved controversial and resulted in several rounds of public hearings as well as a large volume of written comments that the agency is required to analyze.

Often the first reaction of those who suspect indoor air pollution or complain of poor IAQ is to request tests of indoor air samples for specific pollutants. Generally, such tests, which can be very costly, fail to reveal the presence of chemical and other pollutants at levels significantly above those that are normally found in outside air. In addition, the lack of baseline information on pollutant concentrations in typical large buildings and baseline rates of occupant symptoms in such buildings has made comparisons and informed analyses problematic. Without this baseline information, measurements obtained by investigators in problem buildings are of limited value. That is why both EPA and NIOSH generally encourage those responsible for ensuring healthy air quality in buildings to focus first on a building's conditions and ventilation, including the operation and the maintenance of ventilating systems and the provision of sufficient quantities of fresh air, rather than the expensive and frequently inconclusive testing of indoor air samples for specific pollutants. NIOSH, which has conducted hundreds of investigations of complaints of poor IAQ, has noted the following:

- Problems NIOSH investigators have found in the nonindustrial indoor environment have included poor air quality due to ventilation system deficiencies,

overcrowding, volatile organic chemicals from furnishings, machines, structural components of the building and contents, tobacco smoke, microbiological contamination, and outside air pollutants; comfort problems due to improper temperature and relative humidity conditions, poor lighting, and unacceptable noise levels; adverse ergonomic conditions; and job-related stress. In most cases, however, these problems could not be directly linked to the reported health effects.

- Measurement of indoor environmental contaminants has rarely proved to be helpful in determining the cause of symptoms and complaints, except where there are strong or unusual sources, or a proven relationship between contaminants and specific building-related illnesses. The low-level concentrations of particles and variable mixtures of organic materials usually found are difficult to interpret and usually impossible to causally link to observed and reported health symptoms.

FEDERAL AGENCIES' INVOLVEMENT IN INDOOR AIR QUALITY ISSUES IN VERMONT

Consistent with the limited role of the federal government in issues related to indoor air quality (IAQ), we found that federal agencies have not been directly involved in a major way in investigating, evaluating, or mitigating problems of poor IAQ at most of the allegedly "sick buildings" we were asked to examine, in particular, public schools and state office buildings in Vermont. However, where reported indoor air problems more directly affected the interests and responsibilities of individual federal agencies, such as at the headquarters of the Environmental Protection Agency (EPA) in Washington, D.C., and the Fallon Federal Office Building in Baltimore, Maryland, we found that federal agencies played a greater role in investigating, evaluating, and attempting to resolve these problems. Despite the generally limited federal role in directly addressing the problems of most sick buildings, we identified several instances of direct assistance by federal agencies to state and local officials in Vermont, as well as numerous examples of indirect assistance to Vermont officials to help them better understand and respond to the indoor air pollution problems confronting them.

EPA HAS FOCUSED ON INCREASING AWARENESS AND UNDERSTANDING OF IAQ PROBLEMS

Because of the essentially nonregulatory nature of EPA's Indoor Air Program and its limited resources, EPA has had little direct involvement in investigating, evaluating, and mitigating indoor air problems in the Vermont public schools and state office buildings that were included in our review. Despite these constraints, EPA has undertaken several efforts in Vermont to increase awareness and understanding of indoor air problems among state and local officials and to enhance their ability to deal with them in a comprehensive and cost-effective manner.

EPA's Region I Indoor Air Program, which serves Vermont and five other New England states, consists of two professional employees–a regional toxicologist who heads the program and her deputy, an environmental engineer. This region's fiscal year 1998 budget for the Indoor Air Program is approximately $130,000, which is primarily for grants and cooperative agreements for training, outreach, and information dissemination throughout New England. Although EPA's Indoor Air Program is not designed, nor is it able, to provide routine on-site investigations of suspected indoor air pollution at individual buildings within states, we identified three cases in Vermont in which EPA had assisted in investigations and evaluations. In one case, Region I provided the services of its regional laboratory to assist Vermont's environmental protection agency to test for emissions of volatile organic chemicals at the North Country High School in Newport, Vermont. In a second case, EPA offered the services of its regional laboratory to help

test indoor air samples taken at the Waterbury State Office complex in Waterbury, Vermont. In a third case, EPA offered the services of another of its laboratories to test carpet samples taken from the Chittenden Bank Building, which is used by the state to house the Vermont Public Services Board (see enc. IV for a detailed discussion of conditions at these buildings).

While EPA's direct contributions to diagnosing and solving the IAQ problems of specific sick buildings in Vermont have been limited, its indirect contributions–primarily information dissemination, technical assistance, training, and public outreach–have enhanced the state's ability to effectively address its IAQ concerns. For example, since EPA published its Indoor Air Quality Tools for Schools Kit in May 1995,[1] it has distributed over 400 copies of the kit free of charge to school administrators, school nurses, teachers, state agency personnel, and other interested parties in Vermont. This kit, containing an indoor air coordinator's guide, several practical checklists, IAQ background materials, and a videotape devoted to "ventilation basics," describes a comprehensive strategy to diagnose, solve, and communicate about indoor air problems in schools and, perhaps more importantly, to take proactive maintenance and other measures to prevent such problems from developing in the first place.

To promote awareness and understanding of the IAQ Tools for Schools Kit, EPA has sponsored two major conferences in Vermont. The first, held in May 1995 in Burlington, was made possible by a $12,000 grant from EPA to the University of Vermont's Continuing Education Program. The conference was attended by more than 100 participants, including school board officials, school administrators, teachers, nurses, school maintenance supervisors, industrial hygienists, and state and EPA officials. A second workshop to promote awareness and use of the kit was held in November 1996 in Montpelier. This conference, which was jointly sponsored by EPA Region I and the American Lung Association of Vermont, was attended by various individuals with an interest in IAQ in Vermont schools and included representatives of public interest organizations as well as representatives of HVAC firms. The Vermont Department of Health was part of an IAQ panel at the May 1995 conference and had an IAQ information booth at both conferences.

Since the second workshop, staff from EPA's Region I Indoor Air Program have concentrated their efforts on helping to implement the strategies and procedures contained in the IAQ Tools for Schools Kit. They have coordinated with staff of the Vermont Department of Health to follow up on the kit's use by school officials and others who participated in the two workshops and have awarded a $5,000 grant to a nonprofit

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[1]This kit is largely based on a more technical, specialist-oriented publication, Building Air Quality: A Guide for Building Owners and Facility Managers, EPA, NIOSH, Dec. 1991.

organization, the Vermont Public Interest Research and Education Fund, to fund a pilot program for IAQ Tools for Schools implementation. Under this grant, five Vermont schools reported to have IAQ problems will be recruited to participate in systematically implementing the team approach for helping to ensure good indoor air quality that is embodied in IAQ Tools for Schools.

In August 1997, EPA detailed a professional employee from its Washington headquarters to Vermont's Department of Health in Burlington to serve as an "indoor air specialist." This individual, whose assignment is for at least 1 year and whose salary is paid by EPA, has been providing technical assistance and expert support to the Health Department and to other state government entities concerned with IAQ. This detail has enabled the Department to resume investigations of IAQ complaints that had been suspended in 1995 after the retirement of one its most experienced employees. It has also enabled the Department to devote more staff time to actively promoting IAQ Tools for Schools with school officials. Additionally, this specialist, along with indoor air staff of EPA Region I, has worked closely with the Vermont State Indoor Air Quality Committee's Subcommittee on Schools to comprehensively address IAQ concerns in state schools and develop strategies to help ensure good indoor air in these facilities.

Other efforts that EPA has made to enhance Vermont's ability to ensure good air quality in its schools and public buildings include the following:

- In September 1994, EPA Region I awarded a $12,000 Pollution Prevention Incentives for States Grant to the Vermont Department of Health to evaluate sources of indoor air pollution in Vermont public school buildings that represented four distinct historical construction periods and design types. The purpose of this study was to increase understanding of the unique indoor air-related characteristics, problems, and susceptibilities of each of the major types of schools in the state. It involved detailed site inspections and the identification of all possible sources of emissions of chemicals into the air, sources of microbiological growth, and particulate build-up.

- For several years, EPA Region I has sponsored the New England Indoor Air Quality Workgroup. This workgroup is composed of representatives of EPA; all six EPA Region I states, including Vermont (represented by staff of the Department of Health); and representatives of other federal agencies concerned with indoor air issues, such as the Occupational Health and Safety Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH) and the Consumer Product Safety Commission. The workgroup meets quarterly and serves as a forum to exchange technical information, research findings, federal and state IAQ documents, and information on IAQ-related concerns and activities throughout New England.

NIOSH'S INVOLVEMENT IN INVESTIGATING AND EVALUATING IAQ PROBLEMS IN VERMONT

NIOSH, which is part of the Department of Health and Human Services, was created in 1970 by the same legislation that created OSHA.[2] NIOSH's primary mission is to identify the causes of work-related diseases and injuries, evaluate the hazards of new technologies and work practices, create ways to protect workers from those hazards, and make recommendations for occupational safety and health standards. In addition to conducting or sponsoring research to fulfill its mission, NIOSH performs investigations to evaluate possible health hazards in the workplace. The investigations are conducted in response to requests from employers, authorized representatives of employees, and under certain conditions employees themselves, to determine whether any substance normally found in their workplace has potentially toxic effects in the concentrations used or found there.

From 1971 through 1997, NIOSH received over 2,700 requests for health hazard evaluations involving complaints regarding indoor air quality, which NIOSH prefers to characterize as "indoor environmental quality." Since the early 1980s, these complaints have been the single largest category of complaints received; in 1993 they were the basis for nearly 73 percent of all requests. While not all requests for health hazard evaluations involving indoor air can be satisfied, because of resource constraints, competing investigative priorities, lack of standing of the complainant, or other factors, many such requests have resulted in NIOSH investigations. At an OSHA rulemaking hearing on IAQ in late 1994, the director of NIOSH testified that the agency had conducted over 1,500 health hazard investigations involving IAQ and that these evaluations covered a wide variety of building designs and occupational settings, including office buildings, schools, and health-care facilities. The knowledge and understanding gained from these field investigations served in large part as the basis for NIOSH's collaboration with EPA on the 1991 publication Building Air Quality: A Guide for Building Owners and Facility Managers.

Of the 31 health hazard evaluations NIOSH has performed in Vermont as of January 1998, at least 13 (42 percent) involved complaints related to IAQ. Three of these evaluations involved complaints about particular public schools and state office buildings that were included in our review–the Montpelier High School in Montpelier, the Vermont Department of Agriculture in Montpelier, and the Blue Mountain Union School in Wells River. While the first two evaluations resulted in published reports, NIOSH personnel

[2]The Occupational Safety and Health Act of 1970, P. L. No. 91-596, section 22, 84 STAT. 1590, 1612 (1970).

said that because a full-scale investigation was not performed at the Blue Mountain Union School, no report was prepared.

NIOSH's 1992 investigation of the Montpelier High School was performed in response to a request made by Senator Patrick Leahy's office. Several teachers and students complained about the school's IAQ after new carpeting had been installed and remodeling and renovation work had been performed in September 1991. NIOSH investigators interviewed the teachers who had complained of headaches and throat and eye irritation. In addition to collecting and testing air samples for analysis of emissions from volatile organic compounds, NIOSH reviewed the results of the work of private environmental consultants who evaluated the school's IAQ in October 1991. NIOSH's report was inconclusive regarding the cause or causes of the symptoms experienced by the affected students and teachers (most of whom were no longer experiencing symptoms at the time of the investigation). The report noted that

> "The health symptoms which were prevalent at the beginning of the school year resolved over time....Neither the environmental results from the consultants nor those from our investigation could support the proposition that the new carpeting in the school alone was responsible [for the symptoms experienced]."

NIOSH's report said that measurements made by the consultants indicated that the school building was not well ventilated. The report also said that modern HVAC engineering practices suggest that a system providing filtered outside air, in amounts sufficient to control odors and dilute contaminants, would be preferable to the school's ventilation system because permanent building modifications had compromised the system's effectiveness. NIOSH recommended that a contractor experienced in designing HVAC systems be hired to determine whether the school's system could be modified to provide adequate ventilation. The optimal course, the report said, would be to redesign the system to provide filtered outside air. (See enc. IV for additional information).

NIOSH's investigation of IAQ complaints at the Vermont Department of Agriculture headquarters building in Montpelier was also initiated in response to a request from Senator Leahy's office. This request was based on complaints of respiratory and irritative symptoms (headache, excessive fatigue, eye irritation, and nasal congestion) made by Agriculture Department employees following building renovations. NIOSH's protocol for this investigation included a walk-through inspection of the building, interviews with affected workers, and monitoring for carbon dioxide, as well as total and individual volatile organic compounds. Because of instrument malfunction, however, carbon dioxide was not measured.

Although NIOSH's investigation was not conclusive as to the specific cause or causes of the reported health symptoms, the onset of symptoms seemed to be closely associated

with renovation activities–including painting, plastering, varnishing, and installing carpeting and modular workstations–in a building that had no mechanical ventilation system or air-conditioning. NIOSH's report recommended increasing the capability to bring fresh air into the building's first floor, which had relatively few openable windows, and providing blinds, air-conditioning, or some other means to moderate indoor temperatures during the summer months. It also recommended using low-emission materials in future remodelling and renovation work (see enc. IV for additional information).

ROLE OF VERMONT OFFICIALS IN ADDRESSING IAQ PROBLEMS

In the absence of a significant federal role in monitoring and regulating IAQ, this responsibility falls primarily upon state and local officials for public buildings and on the owners of private buildings. In Vermont, the Departments of Health, Labor and Industry, Public Buildings and General Services, and Education, along with local school boards and school administrators, have been most involved in addressing issues of IAQ and the problems of specific sick buildings. This involvement has included comprehensive measures to reduce the incidence of indoor air pollution and related illnesses, as well as more targeted measures to investigate, evaluate, and mitigate reported cases of indoor air pollution in specific buildings.

While there is no single, established procedure in Vermont for filing complaints about suspected indoor air problems and obtaining assistance in dealing with these problems, several options are available to those who have concerns about the healthfulness of the air in their schools and office workplaces. Complaints about IAQ may filed with the Vermont Department of Health or with the Vermont Department of Labor and Industry, both of which have the ability to do limited investigations of IAQ and provide information, advice, and referrals to private indoor environmental specialists. In the case of state government employees, complaints may be filed not only with the two aforementioned departments but also with the Department of State Buildings and General Services. State government employees may also file complaints with the Vermont State Employees' Association (VSEA), specifically with the Association's Safety and Health Maintenance Committee. Additionally, as discussed in Enclosure II, employers, employee unions, and employees themselves may file complaints with NIOSH and request that agency to perform a health hazard evaluation of their workplace. While not all requests for health hazard evaluations can be satisfied, NIOSH will always provide information and advice on dealing with indoor air concerns and make suggestions regarding other public and private sources of expert assistance. Furthermore, EPA, while not equipped to provide on-site investigation of suspected indoor air problems, is, nevertheless, also able to provide information, advice, and various types of technical assistance, as well as guidance on other available sources of help.

THE ROLE OF THE VERMONT DEPARTMENT OF HEALTH

The Vermont Department of Health, specifically the Office of Environmental Health and Toxicology within the Department's Division of Health Protection, has played the lead role in addressing IAQ issues and investigating IAQ complaints in Vermont. Starting in 1991, with a reorganization of environmental responsibilities within the state government that resulted in additional staff resources for the Department, the Office began to investigate complaints of poor IAQ, that came primarily from schools and occupants of

state buildings. According to Office of Environmental Health and Toxicology officials, the staff member who had handled these complaints would typically walk through the site to inspect it, gather information from complainants and others, perform limited testing of the indoor air, and offer advice on correcting obvious problems, including recommending the hiring of indoor air specialists when necessary. When this staff member retired in 1995, the position was eliminated as part of an initiative to downsize the state government. As a result, the Health Department returned to an earlier approach of using telephone consultations which consisted of providing advice and literature and making referrals. In the fall of 1997 on-site investigations resumed, when an EPA indoor air specialist was detailed to the Department and another staff member who had been receiving ongoing training in various aspects of indoor air quality and testing was made available to the program.

Our discussions with Department of Health staff and our review of records relating to IAQ complaints showed that since 1991 the Office of Environmental Health and Toxicology has had significant involvement in investigating, evaluating, and offering advice on ways to mitigate indoor air problems in many schools and public buildings in Vermont, including several of the buildings included in our review. For example, we found that its staff have been involved in investigations and evaluations at the Blue Mountain Union School, the Colchester Middle School, the Middlebury Senior High School, the Missisquoi Valley Union High School, the Montpelier High School, the North Country High School, the Otter Valley Union High School, the Twinfield Union School, the Burlington State Office Building, the Chittenden Bank Building, the Department of Motor Vehicles Building, the Springfield State Office Building, and the Waterbury State Office Building (see enc. IV for additional information).

Department of Health personnel have also publicized EPA's IAQ Tools for Schools Kit and promoted its use by Vermont school authorities. Department personnel, specifically the toxicologist who heads the Office of Environmental Health and Toxicology and members of his staff, have also participated in and provided valuable support to the activities and deliberations of the Vermont Indoor Air Quality Committee and its Subcommittee on Schools. The Subcommittee on Schools, whose work was farthest advanced at the time of our review, is expected to propose IAQ standards (primarily ventilation standards) and standards for new school construction and renovation that could have far-reaching effects in improving the IAQ of Vermont's public schools.

THE ROLE OF THE VERMONT DEPARTMENT OF LABOR AND INDUSTRY

Vermont is one of 21 states that OSHA has approved to establish and administer its own comprehensive job safety and health program.[1] Such a state managed program, which takes the place of direct OSHA involvement in that state, must (1) be based on state enabling legislation, (2) provide coverage of state and local public sector employees (OSHA does not cover such employees), and (3) set job safety and health standards that are "at least as effective" as comparable federal standards.[2] OSHA monitors each state's program and funds up to half of its operating costs, on a matching basis. Vermont's occupational safety and health program (VOSHA) is administered by the Department of Labor and Industry, with the Department of Health providing assistance with health inspections under an interagency agreement.

Neither current OSHA nor comparable VOSHA standards on permissible exposure limits to a variety of chemical compounds and other potentially harmful substances have much relevance to the air quality complaints commonly encountered in indoor work settings, such as schools and office buildings. Because these standards were originally developed for the industrial work environment, they permit exposure levels that are much higher than those typically encountered in the nonindustrial indoor work setting. As a matter of policy, OSHA does not devote significant resources to investigating nonspecific complaints about alleged sick buildings because routine testing of indoor air would generally not disclose violations of existing standards and OSHA believes that its limited resources must be used to investigate more serious threats to worker health and safety in occupational settings. According to a senior VOSHA official, OSHA, for the same reasons, also encourages states with approved programs to refrain from performing routine IAQ investigations. According to OSHA headquarters officials, OSHA's policy is to handle nonspecific sick building complaints informally by referring the complaints to employers and requesting that they investigate and report the results of the investigation, as well as any measures taken to mitigate identified problems. However, OSHA's policy is also to investigate directly any IAQ complaints relating to acute health hazards, such as lead and asbestos exposure, and such building-related illnesses as Legionnaires' disease.

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[1]In addition, there are two such comprehensive OSHA-approved programs operating in the U.S. Virgin Islands and Puerto Rico as well as two state programs, in New York and Connecticut, where OSHA has approved state coverage of state and local public sector employers only. In these states OSHA itself provides coverage of private sector employers.

[2]A state approved by OSHA to manage its own job safety and health program may establish more stringent standards as well as standards covering hazards not addressed by federal standards.

Notwithstanding OSHA's policy and guidance, VOSHA has a policy to investigate all IAQ complaints that are referred to it. According to VOSHA's program manager, the state agency, unlike OSHA, is not so burdened with complaints involving other, more serious worker safety and health issues that it must assign IAQ complaints a low priority. He estimated that over a period of several years, VOSHA had received a total of no more than 15 complaints involving IAQ, which represented a small percentage of the agency's total investigative workload. Most of these complaints came from employees rather than from employee unions, although requests for investigation of complaints involving indoor air quality in state office buildings have generally come to VOSHA through the Vermont Safety and Health Committee, which was established under the state's contract with VSEA, the bargaining unit for the state's nonmanagement employees.

Our examination of the Department of Health's investigation files on IAQ complaints showed that VOSHA has investigated, at least to a limited extent, IAQ complaints involving the following public schools and state office buildings included in our review: the Colchester Middle School, the Missisquoi Valley Union High School, the Otter Valley Union High School, the Chittenden Bank Building, the Department of Agriculture Building, the Department of Motor Vehicles Building, the Springfield State Office Building, and the Waterbury State Office Building (see enc. IV for additional information).

The Department of Labor and Industry is also helping to improve the quality of indoor air in Vermont's public buildings through its participation in the Vermont Indoor Air Quality Committee's Subcommittee on State Buildings. According to the head of VOSHA, the Commissioner of the Department chairs the Subcommittee, which is expected to propose that Vermont establish an IAQ complaint protocol as well as a protocol designed to help ensure maintenance of good air quality in state buildings. According to state officials, these proposals involve naming an indoor air coordinator for each state office building who would serve as a focal point to receive and refer complaints involving IAQ and comfort issues. The Subcommittee's final report is also expected to adopt many of the recommendations contained in the draft report of the Schools Subcommittee, such as eliminating carpeting, where appropriate, to improve building cleanliness and reduce the potential for buildup of dust, dirt, and microbiological pollutants. Officials of the Department of Buildings and General Services told us that the State Buildings Subcommittee has borrowed from the EPA/NIOSH publication, Building Air Quality: A Guide For Building Owners and Facility Managers, in formulating its proposed recommendations.

THE ROLE OF THE DEPARTMENT OF STATE BUILDINGS AND GENERAL SERVICES

According to officials of the Vermont Department of State Buildings and General Services, their agency is the state agency responsible for managing the inventory of

buildings owned or leased by the state to house the various state agencies. The Department has responsibility for approximately 400 buildings, including 274 state-owned properties and around 100 leased properties. Many of these buildings are small structures and several of them, such as the Montpelier headquarters of the Vermont Department of Agriculture (constructed in the 1890s), are quite old. Many of the older buildings in the Department's inventory are not equipped with mechanical ventilation systems or air-conditioning. In addition, numerous buildings were not originally constructed for use as office buildings and have been adapted to this use with varying degrees of success. For example, the Springfield State Office Building was originally built as a supermarket and was later used as a furniture store before being converted to its present use.

While the Department is responsible for properly maintaining buildings under its control, investigating occupants' complaints regarding air quality and comfort issues, and taking appropriate measures to remedy IAQ problems, it does not possess the means to do sophisticated investigations and evaluations of suspected indoor air pollution. For this purpose, the Department relies primarily on the state Department of Health, VOSHA, and private contractors. For example, the Department has spent approximately $100,000 to have others investigate the causes of indoor air problems at the Chittenden Bank Building and determine what remedial measures were appropriate (see enc. IV for additional information).

The Department's role in maintaining good IAQ in state buildings is an evolving one that has been the focus of increasing attention in recent years. The numerous IAQ complaints lodged by state employees in the early years of this decade have prompted state officials to question existing procedures for handling and resolving complaints and to examine what might be needed to enhance the prevention of indoor air problems in state buildings. Such questions and concerns contributed to the establishment of the Vermont Indoor Air Quality Committee and its Subcommittee on State Buildings. According to Department officials, some of the steps which they have taken or plan to take to address concerns about IAQ in state buildings include the following:

- In 1993, the Department prepared a brochure to explain to state employees how and where they might report concerns related to their work environment. The procedures outlined in the brochure were designed to direct all complaints related to indoor air in state buildings to the Department and to promote quick local resolution of them. This brochure has been followed by the development of a more elaborate complaint protocol, based on guidance contained in the EPA/NIOSH Building Air Quality Guide, that is expected to be endorsed by the state IAQ Committee in its final report.

- The Department is developing a comprehensive protocol governing maintenance of state buildings. The protocol will establish required maintenance procedures

and include requirements for keeping records of periodic maintenance inspections. As part of a greater emphasis on preventive maintenance to preclude the development of indoor air problems, the Department is considering proposing cleaning specifications for HVAC systems in state buildings, covering, among other things, the cleaning of ventilation ducts by private contractors.

- The Department has implemented a policy, originally developed by Vermont's Department of Personnel, governing smoking in state buildings. This policy, while delegating ultimate authority to local work site committees, has virtually eliminated smoking in these buildings.

- The Department has adopted more conservative, selective, and openly communicated pest control procedures. No longer relying primarily on private pest control firms over whose procedures it had little control, the Department has trained its own personnel in pest management and established its own pest control protocol. Now test trappings are performed before any pesticide application is done to determine the specific nature of the problem and which control techniques are likely to be most effective. Pesticides are not applied during working hours and building occupants are notified in advance of the specific control measures that will be applied, provided access to information on any pesticides to be employed, and given the opportunity to leave the building to avoid exposure. Similar advance notification procedures have been adopted to inform building occupants of any planned painting, heavy cleaning, carpet installation, construction, renovation, or significant repair activity.

- The Department is coordinating with the Vermont Clean State Council and other organizations to procure "green" (i.e., environment friendly and relatively less toxic) products, equipment, and furnishings for use in its buildings. Among other measures, it has specified the use of carpeting that does not emit volatile substances frequently implicated in complaints of poor IAQ.

THE ROLE OF THE DEPARTMENT OF EDUCATION

Historically, Vermont's Department of Education has not played a significant role in investigating, evaluating, and remediating indoor air problems in state schools, primarily because education has been regarded as a local responsibility. The role of the Department in ensuring good IAQ in schools is likely to increase, however, as a result of recent legislation designating public education as a state responsibility in Vermont and providing state funds to construct new schools as well as operate, maintain, and repair existing ones. The recommendations in the forthcoming report of the Subcommittee on School Buildings are also likely to contribute to a more important role for the Department in maintaining good air quality in schools.

The Subcommittee on School Buildings of the Vermont Indoor Air Quality Committee is cochaired by the General Counsel of the Department of Education and by a teacher in the Vermont public school system. In addition, the Subcommittee's membership is comprised of officials of the departments of Education, Health, Labor and Industry, other active and retired school teachers, parents, architects, building engineers and construction consultants, as well as representatives of various Vermont advocacy groups. During the 1997-1998 school year, the Subcommittee met several times to consider recommendations for school construction and for designing and maintaining school buildings to preclude or mitigate indoor air problems. The Subcommittee also explored protocols to respond to IAQ complaints as they arose, both at the building level and at the state government level. While the Subcommittee has not yet delivered its final report, which will be subject to review within the state government and to public hearings and debate, the draft of this report (which we have reviewed) made several recommendations with potentially far-reaching implications to improve the IAQ in Vermont schools.

For newly constructed schools and schools with substantial additions and renovations, the draft report recommends that Vermont adopt as its construction and operating standard a modified version of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers' (ASHRAE) proposed ventilation standard (Standard 62-1989R) "Ventilation for Acceptable Indoor Air Quality."[3] The Subcommittee found this standard to be "the most important and measurable standard currently available, with the least amount of bureaucracy involved and consistent with the state of existing technology."

The component of the draft ASHRAE standard on "Outdoor Air Requirements for Ventilation" requires at least 15 cubic feet per minute (cfm) of outside air per person for school classrooms and also that a room's maximum occupancy rate be used to determine the ventilation rate. Recognizing the difficulty and the expense of imposing this standard in existing classrooms, the Subcommittee's draft report, recommends that all existing classrooms be ventilated at least to the greater of their original or modified design standards and that in no case should a classroom receive less than 5 cfm of outdoor air per person provided by mechanical ventilation. The draft report also recommends that

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[3]This draft standard, since withdrawn by the ASHRAE Board of Directors, contains requirements for areas in commercial, institutional, and residential buildings intended for human occupancy. It considers chemical, physical, and biological contaminants, as well as moisture and temperature, that can affect human health and perceived air quality. In addition to general requirements related to HVAC system design, filtration, placement of air intakes and exhausts, it covers ventilation rates, HVAC system construction and start-up, and operating and maintenance procedures.

certain areas in schools receive ventilation designed specifically to address the increased likelihood of pollutants. Such areas include restrooms, areas containing office equipment, science laboratories, kitchens, art rooms, and technical and vocational education areas. With respect to specific indoor pollutants, the draft report recommends that the departments of Health and Education develop guidelines, periodically updated as technology improves, on permissible levels in the indoor air of such pollutants as ozone, radon, mold, formaldehyde, respirable dust, asbestos, carbon monoxide, carbon dioxide, and nitrogen dioxide, as well as protocols for the periodic testing of indoor air and resolving complaints.

To maintain appropriate IAQ in schools and more effectively respond to complaints, the Subcommittee's draft report recommends that schools adopt processes for addressing IAQ issues that are essentially those described in EPA's IAQ Tools for Schools Kit: namely, fix any existing indoor air problems, promote awareness of IAQ issues conducive to preventative school maintenance and operations, and resolve IAQ complaints and incidents as they occur. To accomplish this, the draft report recommends adopting the kit's suggestion to appoint an IAQ coordinator at the highest levels of a school's or school district's administration. Finally, to complement the Department of Education's proposed rules for new school construction, the draft report recommends that the Department establish construction guidelines designed to maximize air quality. These guidelines should include provisions for (1) site selection; (2) the design, selection, and installation of HVAC equipment; and (3) the design, selection and construction of a building's shell, finishes, and furnishings. As part of the last provision, the Subcommittee recommends avoiding flat roofs, windowless interior rooms, carpeting, and mobile classrooms (unless they can meet the proposed standards for ventilation and IAQ).

IAQ PROBLEMS AND ACTIONS TAKEN IN VERMONT BUILDINGS

VERMONT'S PUBLIC SCHOOLS

Blue Mountain Union School, Wells River

The Vermont Department of Health first visited the Blue Mountain Union School in September 1992 and again in January and February 1993 to investigate its IAQ. The visits were in response to high absenteeism of students and teachers and their health complaints. The investigations revealed elevated carbon dioxide levels in 10 of the 12 areas tested. Carbon dioxide levels in some rooms were almost twice recommended levels. (ASHRAE has recommend that carbon dioxide levels should not exceed 1,000 parts per million, and that the goal should be 800 parts per million.) The Department of Health recommended hiring a HVAC firm to evaluate the ventilation system, replacing worn carpets with tile or wood floors, and replacing water-damaged ceiling tiles. The Department's investigation also looked for the presence of specific volatile organic compounds–toluene, xylene, and benzene–which were not detected.

In January 1994, a private consultant who investigated the school's IAQ thought that the building met the definition of a "sick building" because 20 percent or more of the occupants had reported health effects. The consultant reported that 90 percent of the 44 employees responding to a health survey associated their health problems with their presence in the building. According to the consultant, the air quality problems involved a combination of inadequate ventilation and the presence of several sources of indoor air pollutants.Although the ventilation system was originally designed to provide 35,000 cfm of outdoor air, it was providing only 1,500 cfm of outside air.

Because of the high cost of electric heat and Vermont's cold winters, the school had closed off all room air intake registers and reduced the capacity of the roof air intake. The consultant recommended that the school restore its ventilation system to its original design as well as implement such low-cost actions as relocating the bus loading and unloading area, ceasing the use of certain cleaning products, removing carpeting, moving the copy and lamination machines to ventilated sites, and developing a plan to control the moisture.

In early March 1994, the Blue Mountain Union School notified the students' parents of the consultant's findings and the actions taken and planned to address the problems related to the school's IAQ problems. After a new air-handling system was installed later that year, the Vermont Department of Health retested the school's air in March 1995. The tests showed that carbon dioxide levels were substantially improved over previous levels

and that the ventilation system appeared to be working well. In October 1997, the Vermont Department of Health encouraged the school to adopt EPA's IAQ Tools for Schools Kit.

Colchester Middle School, Colchester

In March 1993, the Vermont Department of Health conducted a limited indoor air survey of the Colchester Middle School. Although the ventilation appeared to be adequate, the Department's report recommended that any areas where carbon dioxide levels exceeded 1,000 parts per million be checked for possible blockages or separations in the ventilation system. It also recommended periodic maintenance of the ventilation system, adding steam to increase humidity, and replacing carpets with tile in high-traffic areas.

In April 1994, VOSHA received a complaint of poor ventilation at the school, including the presence of bus exhaust fumes, molds under carpets, and persons suffering such health problems as headaches and sinus infections. In a June 1994 report, VOSHA notified the school that while it found no violations of VOSHA standards that were related to that complaint, carbon dioxide levels exceeded 1,000 parts per million in several classrooms. VOSHA recommended inspecting and cleaning the air-handling units and conducting an air-balancing study.

In September 1996, VOSHA again received complaints about Colchester Middle School. Among the 22 complaints were alleged health hazards involving leaks and molds, stagnant water near air intakes, dirty air filters and ducts, and the improper use of pesticides and chemicals. VOSHA's final report did not cite any violations of its standards because VOSHA does not have a specific IAQ standard. Also, the report noted that many of the complaints had either been addressed or would be addressed through a planned renovation of the school that included upgrading its ventilation system. The report noted a lack of trust between administrators and school employees and encouraged the school to improve communications about IAQ issues through a recently formed committee on IAQ.

In November 1997, the Vermont Department of Health visited the Colchester School and observed the renovations underway to clear blocked air ducts and to raise the outdoor air intakes off the ground. The Department said that these improvements should increase the amount of fresh air entering the school while decreasing the amount of dirt and dust entering the air-handling units. The Department noted that the ventilation system should be balanced to distribute the air more equally. In addition to finding some exhausts that were not working, the Department recommended that the school take actions to prevent odors and pollutants from escaping from the wood shop and spreading to other parts of the building.

Middlebury Union Senior High School, Middlebury

In a January 1993 survey conducted by Congressman Bernard Sanders of Vermont on the IAQ in Vermont's schools, a former administrator at the Middlebury Union Senior High School characterized the school's air quality as marginal. The administrator complained that he had spent hundreds of hours on IAQ issues because the school's ventilation was poor, the roof leaked, molds were present, and staff and students were complaining of headaches and upper respiratory problems. The administrator recommended that IAQ standards be established.

As part of its efforts to follow up with schools that it had dealt with on indoor air problems, in October 1997, the Vermont Department of Health contacted the school to encourage it to implement the recommendations contained in EPA's IAQ Tools for Schools Kit. The school informed the Department about the improvements it was making to its ventilation system and the installation of a new pitched roof.

Missisquoi Valley Union High School, Swanton

Between 1989 and 1995, reports by various consultants revealed that the Missisquoi Valley Union High School had numerous indoor air problems, including poor ventilation, water-damaged areas with mold, inadequate climate control, and cross contamination of intake air with exhaust air. The reports noted that aside from initial design deficiencies, walls had been constructed that disrupted air flow and periodic maintenance had not been performed. Recommendations included such actions as conducting an evaluation of the HVAC system to determine if it meets current standards; relocating air intakes from problem areas; implementing a cleaning and maintenance program for the ventilation system; replacing worn carpets with tile; and establishing a log of occupant complaints.

The Vermont Department of Health and VOSHA also inspected the school for indoor air problems. In December 1992, the Department of Health inspected the school and cited several problems that lowered the school's IAQ. In June 1993, VOSHA fined the school $4,750 for various violations of its standards, although none of them involved IAQ.

In October 1997, the Vermont Department of Health received an anonymous complaint from a person experiencing respiratory problems at the school. A follow-up call by the Department indicated that the school was undergoing extensive renovation, including major ventilation improvements, and that while much of the work had been done over the summer, some work was being done at the beginning of the school year. The Department of Health advised the school of EPA's IAQ Tools for Schools Kit, which, among other things, addresses matters that should be considered during renovation projects.

Montpelier High School, Montpelier

In the fall of 1991, the Montpelier High School reported problems with its IAQ and requested testing it as well as the carpets for the presence of 4-phenylcyclohexene, a chemical by-product created during the manufacturing of carpets. Because the Vermont Department of Health did not have the capability to test the carpets, Senator Patrick Leahy of Vermont requested EPA's assistance in the matter. Although EPA did not have an indoor air program to provide the kind of on-site investigation requested, EPA offered to provide technical assistance to the school. EPA noted that the school had already hired private consultants to test the IAQ and analyze the air for the presence of 4-phenylcyclohexene, volatile organic compounds, and formaldehyde. In November 1991, the Department of Health helped the Montpelier High School evaluate the consultants' work and concluded that although their tests were inconclusive, an inadequate ventilation system seemed to be the cause of the school's indoor air problems.

At the request of Vermont Senator Patrick Leahy, NIOSH subsequently conducted a health hazard evaluation of the school's IAQ. NIOSH's August 1992 report noted that, during September 1991, the teachers and students began experiencing headaches and throat and eye irritation when they were in newly painted and carpeted classrooms. Its tests detected trace quantities of 4-phenylcyclohexene and volatile organic compounds in some air samples. The report also noted that once renovation work is completed, the concentrations of air-borne contaminants typically decrease within a few weeks.

Because permanent building modifications to conserve energy had compromised the effectiveness of the school's ventilation system, NIOSH recommended that the school hire a contractor to evaluate the system to determine if its ventilation could be improved. NIOSH also recommended that the school use building materials and furnishings that have low volatile chemical emissions and seek the advice of carpet manufacturers on airing-out carpets prior to reoccupying an area.

The Montpelier High School is currently in the process of a major renovation that includes improvements to the school's ventilation system. However, the renovation work has resulted in numerous complaints of poor IAQ from students and staff. In February and March 1998, the Department of Health received several complaints about extreme temperatures, odors, and dust emanating from the renovation activity. The Department of Health visited the school and made several recommendations designed to keep the dirt and the dust to a minimum during the renovation work. School officials, cognizant of these problems, have retained a private firm to conduct air monitoring and have decided to limit certain construction activities to times when the school is not occupied.

North Country Union High School, Newport

In May 1995, the Vermont Department of Health visited the vocational rooms of the North Country Union High School in response to a teacher's complaint of allergic reactions. The Department found elevated levels of carbon dioxide and carbon monoxide and several exhaust systems that were either not installed or not working properly. The Department recommended contracting with an engineering firm to design a suitable air-handling system for the vocational shop area and special needs room.

In January 1996, air testing by an engineering firm showed elevated levels of carbon monoxide in the automotive shop area and elevated levels of carbon dioxide in several areas of the school. The report concluded that levels of volatile organic compounds in the shop area could be a source of irritation to sensitive individuals and that a more effective exhaust ventilation was needed. Among the consultant's recommendations were to evaluate the school's ventilation system and establish one log to record maintenance activities and another to record occupant complaints, symptoms, and actions taken. Another consultant's report, made available in August 1996, concluded that inadequate ventilation was occurring whenever unit ventilators in classrooms caused the outside air dampers to close when the thermostat called for heat.

In June 1997, the school requested the Department of Health's assistance in reviewing its plans to improve its IAQ. In September 1997, the Department met with school officials who were planning to retain the services of an engineer that specialized in ventilation design and problem remediation. The Department provided them with technical information on IAQ and advised ceasing operations of the school's kiln due to inadequate venting of fumes.

In December 1997, a student experienced an apparent allergic reaction, lost consciousness, and had to be taken to the emergency room at a local hospital. At least two employees have experienced problems while working at the school and have initiated claims for disability and workers' compensation based on their claims of multiple chemical sensitivities.

At the end of December 1997, the school notified the Department of Health that it was planning to fund improvements to the school's ventilation system and that it had begun to review the cleaning and maintenance products being used at the school.

In December 1997, a private firm recommended relocating the bus parking area and conducting additional tests. Preliminary analysis of dust samples collected at the school showed nothing out of the ordinary. Also, in January 1998, the Vermont Department of Health provided additional advice to the North Country Union High School regarding its ongoing efforts to address the IAQ at the school. In January 1998, the Vermont

Department of Environmental Conservation visited the school to collect samples to test for volatile organic compounds and carbonyls. EPA's Region 1 Laboratory located in Lexington, Massachusetts, was slated to assist in analyzing the results of the sampling.

Otter Valley Union High School, Brandon

In February 1994, the Vermont Department of Health investigated the indoor air at the Otter Valley Union High School. The Department found that carbon dioxide levels exceeded recommended standards in 9 of the 13 classrooms tested and that some classrooms, including mobile classrooms that had been in use for 20 years, did not have mechanical ventilation. The report noted that classroom ventilators needed routine maintenance and servicing and recommended hiring a contractor to test and balance the entire heating and ventilation system as well as installing mechanical ventilation systems in all classrooms that did not have them.

In September 1994, after investigating the school's indoor air problems, VOSHA reported that wet ceiling tiles, insulation, and carpeting were fostering the growth of bacteria and fungi as a result of water leaking through the roof, an ineffective ventilation system, and uncontrollable heat. Although no fines were imposed for poor IAQ, VOSHA fined the school $6,000 for such violations as not providing employees with information and training on using hazardous cleaning products.

On behalf of the Vermont Department of Health, a consultant studied the school's indoor air in April 1995. The consultant judged the ventilation to be inadequate because most classroom ventilators had been turned off, or their controls were out of calibration, or they were not operational. The consultant also noted that most of the gravity relief dampers in classrooms had been sealed, several exhaust fans were not operational, the mobile classrooms had no mechanical ventilation, and many areas originally designed for storage were being used as classrooms although they had no ventilation. The consultant recommended numerous actions to correct the deficiencies. The consultant noted that an annex of the school was scheduled for complete renovation, including a new ventilation system and that the mobile classrooms were scheduled for demolition.

In January 1996, the school received a report from another private consultant that it had retained to determine whether IAQ issues might be associated with health complaints at the school. The consultant reported that of the 55 staff members responding to its survey, 41 reported symptoms that were typical of indoor air pollution. Their symptoms included headaches; eye, nose, and throat irritation; dizziness; drowsiness; and respiratory problems, such as bronchitis or asthmatic reactions. In all but two of the tested areas, the consultant found high carbon dioxide levels indicating that the ventilation system that had been installed in the summer of 1995 was not working properly. The consultant

found mold on ceiling tiles and around lockers in numerous areas with water damage caused by leaks in the roof.

Twinfield Union School, Plainfield

In January and March 1993, the Vermont Department of Health performed limited indoor air testing at the Twinfield Union School in response to complaints by students and teachers. Among the complaints was the presence of bus exhaust fumes in the school. Because carbon dioxide levels exceeded 1,000 parts per million in several areas, the Department recommended checking the ventilation system, performing periodic maintenance, restricting the buses' proximity to the building, and lowering the relative humidity levels. In a March 1994 follow-up inspection report, the Department noted that although carbon dioxide levels generally had improved, several readings still exceeded 1,000 parts per million and recommended that a HVAC firm be retained to examine the ventilation system.

In October 1997, VOSHA and the Department of Health received complaints about unidentified fumes entering the building. When the Department of Health contacted the school, school officials explained that although the buses had been moved and the air intakes had been closed during loading and unloading, exhaust fumes were still entering the building. Since then, the Department of Health has made several calls to the school to keep informed of the actions that have been taken to address its air quality problems and has encouraged the school to implement EPA's IAQ Tools for Schools Kit. The records of the Department of Health indicate that, as of January 1998, the school had retained the services of two private firms to help address its IAQ concerns, such as increasing fresh air levels to reduce carbon dioxide. The school also plans to install a chimney to avoid drawing diesel fumes from buses into the building, to replace the carpeting, and to clean the air ducts.

Union 32 High School, Montpelier

In October 1992, the staff at Union 32 High School petitioned the principal to take actions to address persistent indoor air problems. The staff complained about the possible link between their illnesses, such as headaches, sore throats, eye irritation, nausea, and fatigue, and the recent installation of carpeting that had not been properly aired out. The staff also complained of poor air circulation, widely fluctuating temperatures, and fumes from the oil heating system.

In April 1997, the school received the final report of an engineering firm that had investigated the school's IAQ. The report concluded that complaints of health symptoms at the school were caused by several factors, such as microbial growth (including the

fungus Stachybotrys atra[1]) within the walls, low ventilation rates, ineffective control of temperatures, failure to prevent and clean up water damage, slightly elevated levels of particulates, and possible reentry of gases from the boiler's flue. The consultant's report noted that, over the years, numerous renovations had been made without appropriate adjustments to the school's air distribution system.

To improve the current situation, the consultant recommended such actions as modifying and upgrading the existing ventilation system, including adding heating terminals and upgrading temperature controls, cleaning duct work, rebuilding walls with water-resistant components, cleaning and removing carpeting, and further evaluating the building's water pipes. To improve the school's ventilation system, the consultant outlined two options whose cost would total approximately $1 million.

VERMONT'S STATE OFFICE BUILDINGS

Burlington State Office Building, Burlington

The Burlington State Office Building on Cherry Street was constructed in 1992 and occupied in 1993. Over the years, several investigations have been conducted in response to employees' complaints about air flow, odors, volatile organic compounds, bioaerosols, particulates, and vapors.

In March 1994, the Department of Buildings and General Services inspected the building's air delivery system and found that several of the original high-efficiency air filters had been replaced with less efficient types, about half of the filters had been installed backwards, and several other filters had not been changed regularly. Corrections were ordered, including establishing a maintenance log. In June 1994, the Department met with the building's occupants and maintenance staff to discuss indoor air complaints. Because of concerns that automobile exhausts were entering the building, the indoor air was tested for benzene, toluene, ethyl benzene, and xylenes, but the testing did not indicate any elevated levels.

In January 1996, the Department of Health hired a private contractor to test the building's IAQ because of such health complaints as headaches, eye irritation, and tiredness and the suspicion that recent water damage may have caused them. Although the contractor's report indicated that the carbon dioxide levels, the temperature, and the relative humidity were satisfactory and that fungal and bacteria levels were low, the

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[1]Stachybotrys atra is a toxic fungus or mold that thrives under damp conditions and can produce such symptoms as headaches, sore throat, fatigue, shortness of breath, and other respiratory problems.

contractor suggested retesting the building during the summer because biological growth is typically greatest in warm weather. However, the Department of Buildings and General Services turned down the Health Department's request for retesting because it did not have the funds and it did not believe any retesting would be worthwhile because there had not been any subsequent problems with water damage.

In June 1997, the occupants of the building complained about the sealing, the caulking, and the painting that were being performed in the building's garage without their having received adequate notification and complete information about the hazards of the chemicals being used in the repair work. In January 1998, the occupants of the building received advance notice that additional repairs to the garage would commence soon. However, officials in the Department of Health requested that the Department of Buildings and General Services delay the work until the summer when windows could be opened to increase ventilation.

Chittenden Bank Building, Montpelier

Complaints about the IAQ at the Chittenden Bank Building commenced almost immediately when state employees occupied the building in 1995. State employees had voiced their concern about the building prior to moving in because operable windows were not going to be installed in the building. Since then, the Department of Buildings and General Services, the Vermont Department of Health, VOSHA, and numerous contractors have investigated employees' complaints of poor IAQ. In January 1996, in response to a complaint by the VSEA, VOSHA sampled the indoor air to test for formaldehyde, benzene, ozone, carbon dioxide, fiberglass, dust, relative humidity, and temperature. Although this inspection found no serious VOSHA violations, VOSHA told the Department of Buildings and General Services that it had found elevated carbon dioxide levels and the presence of fiberglass in the air, which might account for employees' complaints of fatigue; eye, skin, and respiratory irritation; hoarseness; headaches; and rashes. VOSHA noted that the illness rate in the building exceeded 40 percent of the occupants, with four employees being relocated to another office building and two employees not being able to return to work at all. VOSHA concluded that there was a severe need to balance and clean the air-handling system and to remove the fiberglass that was found in the return air ducts and was circulating in the air. VOSHA also issued a citation to the Vermont Public Service Board for failure to maintain the VOSHA-required log of accidents, injuries, and illnesses.

In April 1997, the Department of Buildings and General Services obtained the services of a "commissioning" contractor to review the design and the installation of the indoor air remediation work and the overall operation of the entire ventilation system. According to the contractor, ventilation rates have been increased, resulting in lower carbon dioxide levels, and previous levels of volatile organic compounds, particulates, and

fiberglass, which were considered high, have been reduced. The Department of Buildings and General Services told us that an IAQ committee had been established and that preventative maintenance and periodic inspections of the building's systems will be implemented. We observed that copiers have been directly vented to the outside and that operable windows have been installed. However, some outstanding issues remain, including replacing the main air handler's fan motor and variable speed drive before occupancy of the fifth floor and repairing cracks to the roof.

Department of Agriculture Building, Montpelier

Since 1921, Vermont has used the Department of Agriculture Building as an office building. Constructed in the 1890s, it does not have a mechanical ventilation or air-conditioning system. The first floor of the building, which had been used for in-house laboratories, was converted to office space in August 1991. Similar renovations involving moving walls, painting, plastering, carpeting and installing modular work stations have since been done on other floors.

Occupants in the building have been experiencing problems since 1990. Although VOSHA's October 1991 inspection found no violation of its standards, because the complaints centered around recently installed carpeting, the inspector recommended ways to minimize emissions from the carpets. Also, in February 1992, a private contractor conducted biological testing at the building . The fungi and bacteria levels were considered to be in the medium range for IAQ.

In response to a request from Senator Leahy, NIOSH conducted a health hazard evaluation of the indoor air at the building in March 1992. The evaluation consisted of interviewing workers and testing for the presence of 4-phenylcyclohexene and volatile organic compounds. Five of the 10 workers interviewed on the first floor were experiencing such medical symptoms as headaches, fatigue, and eye and throat irritation and complained of excessive heat and poor ventilation in the summer. The air sampling did not detect 4-phenylcyclohexene and showed remarkably low levels of other compounds. Because NIOSH could not identify any specific exposures to explain employee complaints, it recommended increasing ventilation in first floor offices by such measures as modifying the windows to enable employees to open them more fully or installing an air conditioner. If these measures were unsatisfactory, the report recommended installing a mechanical ventilation system.

In October 1995, the Commissioner of Agriculture informed the Department of Buildings and General Services about the occupants' health complaints and stated that claims for workers' compensation had been sought due to the building's poor IAQ. The Commissioner requested that NIOSH's recommendation to install a ventilation system be implemented. The Commissioner of the Department of Buildings and General Services

responded that periodic tests for carbon dioxide over the last 10 years had always found levels that were well within limits. Although funds were not available to install a modern air delivery system, the Commissioner stated that, hopefully, sufficient funds could be made available over the next couple of fiscal years.

After a February 1996 inspection, the Department of Buildings and General Services determined that the building needed a major cleaning, the removal of the basement's floor and wall coverings to search for mold, ventilation and dehumidification in the basement, and better ventilation on the first floor. A cleanup of the entire building, including the basement, was initiated in June 1996. In the spring of 1997, all wall and floor coverings in the basement were removed to look for the presence of mold. However, no visible signs of mold were found, according to state officials. Although the basement would no longer be used for office space, a modest ventilation system was designed for it. The basement was also tested twice for radon, and levels were found to be in compliance EPA's standards. Finally, state officials indicated that operable windows had been installed on the first floor to provide employees with more ventilation.

Department of Motor Vehicles Building, Montpelier

Constructed in the late 1940s, the Department of Motor Vehicles Building operates without a mechanical air-handling system on the third, fourth, and fifth floors. After complaints about poor IAQ, the state had air-handling systems for the basement, first, and second floors installed in 1994. Prior to 1993, there was no history of air quality concerns, according to the Department of Buildings and General Services.

In October 1993, the Department of Health made a limited indoor air survey of the fourth and fifth floors of the building in response to complaints by Department of Education employees. While the inspection found acceptable levels of carbon dioxide, it recommended replacing the carpeting with tile in high-traffic areas, better vacuuming and cleaning of offices, and studying the issue of overcrowding. In April 1994, the Commissioner of the Department of Buildings and General Services requested estimates for installing a mechanical ventilation system for the third, fourth, and fifth floors; using tile to replace the carpeting in the kitchen areas; reviewing the adequacy of the shampooing of the carpets; and making indoor air brochures and complaint forms available to the occupants. In response to employees' complaints of excessively cool air and excessive dust on office furnishings, the Department of Buildings and General Services again inspected the building in August 1995. The inspection revealed that the ventilation system's filters were clogged and needed replacement.

Although a July 1996 inspection by VOSHA in response to a petition from VSEA found no violations of standards, the results of air-monitoring supported the workers' complaints about poor IAQ. VOSHA found elevated carbon dioxide levels in several

areas, dirty air supply vents, and loose fiberglass in the air-handling units, and a rate of air exchange that was minimally acceptable by ASHRAE's standards. According to VOSHA, these conditions and frequent complaints by almost all employees that the building was either too hot or too cold indicated the heating and ventilation system was not supplying a sufficient and balanced volume of fresh air. VOSHA recommended hiring a contractor to evaluate the system, establishing a communications network for IAQ-related complaints, reviewing occupancy levels, and venting office equipment directly to the outside.

In July 1996, the Department of Buildings and General Services initiated major steps to clean and maintain the building. Throughout the first floor, the air supply and return vents, ceiling tiles, and walls were cleaned. The Department indicated that the elevated carbon dioxide levels VOSHA had detected were probably caused by fresh air intakes that were almost completely blocked with pollen and other materials. The Department said that cleaning the second floor's air vents and ceiling tiles would commence soon and that the carpets would be cleaned more frequently. The Department also said that it had switched to high-efficiency filters and that they would be replaced more frequently.

According to the Department of Buildings and General Services, the large number of people visiting the Department of Motor Vehicles has made cleaning the building difficult. Moreover, adequate air filtration and control of particulate matter is almost impossible without mechanical air-handling systems, according to the Department of Buildings and General Services.

Springfield State Office Building, Springfield

In October 1984, the state entered into a 10-year lease of a building to be used as a state office building. This privately owned building had previously been used as a supermarket and as a furniture store. To use the building as an office building, walls and partitions had to be constructed. Since 1985, several public and private inspections have been done in response to employees' complaints of upper respiratory irritation, sinusitis, bronchitis, pneumonia, asthma, drowsiness, fatigue, skin rashes, and eye irritation. In April 1990, VOSHA noted that the distribution of air flow within the building needed to be improved. Although the Department of Buildings and General Services promised to increase the amount of fresh air and address problems with fiberglass insulation, it thought that Vermont should not spend anymore on the building than necessary, because the state tenants might relocate on termination of the lease.

Since 1986, the Department of Health also has noted numerous problems with the building. After an April 1992 inspection, the Department recommended extending the boiler's exhaust stack to avoid cross contamination with the fresh air intakes, replacing the carpeting that had been soaked by substantial flooding, and balancing the ventilation

system to provide sufficient fresh air. The Department also noted that doing any work in the space above the ceiling could disturb the fiberglass insulation that rested directly on the ceiling tiles, thus releasing fibers into the air.

In December 1992, a private inspector's report cited many of the same findings the Health Department had made. Although the air intakes on each of the building's two air-handling units had been increased, the air circulation was still uneven and the amount of fresh air coming into the building still needed to be increased. The contractor also reported that the carpeting had been cleaned instead of being replaced.

In September 1993, the Department of Buildings and General Services inspected the building and cleaned its air ducts. Analysis of samples from the air ducts for possible contaminants, including mold, detected nothing out of the ordinary. Because employees' complaints about poor IAQ continued, in April 1994, the Department demolished the wall and removed the carpeting of an employee's office to search for mold. Although no mold was found, it was noted that the considerable amount of water damage in the ceiling could promote mold.

In February 1995, an epidemiological study of the IAQ by Exeter Hospital and the University of New Hampshire concluded that while biological contamination was the most likely cause of the employees' health complaints, their symptoms were probably provoked by a variety of factors. Although the building has a history of water leaks, most of the materials damaged by the water, such as carpets and ceiling tiles, had not been replaced. Noting that the air-handling units could pick up organisms from the nearby stagnant water on the roof, the study stated that only minimal testing had been done for microbial contamination despite 8 years of complaints. The report also noted loose fiberglass above the suspended ceilings and evidence that the ventilation system needed to be better maintained and cleaned. However, the study made no recommendations because the Department had decided to vacate the building when the lease expired. The lease was terminated in 1995, and the employees were relocated.

Waterbury State Office Building, Waterbury

This complex consists of some 50 buildings that house the Vermont State Hospital, and the building that has experienced the most complaints has been the Dale Building. While approximately 130 employees and 65 patients occupy this building, most of the complaints about poor IAQ have come from workers in the basement level. Since 1990, when a state-licensed environmental/agricultural laboratory was built nearby, many employees have complained of numerous symptoms, including, headaches, fatigue, nausea, nasal congestion, chest discomfort, burning eyes, and dizziness. By 1993, employees on the other three floors began to express similar complaints.

Numerous air-monitoring tests and evaluations of the ventilation system have been made to identify the source of these complaints. Although the Department of Health has checked carbon dioxide levels and tested for volatile organic compounds and the presence of biological contaminants several times, nothing significant was found. VOSHA has tested the air a couple of times and, while citing no violations of its standards, recommended numerous improvements to the ventilation system. The Department of Buildings and General Services and several of its contractors have also evaluated the ventilation system. The Agency of Natural Resources sampled emissions from the environmental/agricultural laboratory and sent them to EPA's Region 1 for analysis. According to VOSHA and the Department of Health, the tests appear to rule out emissions from the laboratory as a possible source of contaminants in the Dale Building.

Many actions have been taken to improve the environment in the Dale Building. In December 1992, water-damaged carpets were replaced with tile. Numerous changes, such as installing a new air intake system for the basement in the winter of 1993, have been made to the air-handling system. To minimize the likelihood of contaminated air entering the building, several air intakes and exhausts have been modified. To minimize biological contaminants, the basement's walls, ceilings, and floors were refinished and put under routine maintenance. About 1 year ago, a cleaning effort was undertaken to rid the building of excess materials that were blocking air return registers and preventing custodians from properly cleaning the building.

Over the years, the frequency of the employees' health-related complaints on several surveys has not significantly changed. While the basement was vacated about 2 years ago, the occupants of the first, second, and third floors of the Dale Building were still complaining about the poor quality of the indoor air.

IAQ PROBLEMS AND ACTIONS TAKEN AT FEDERAL OFFICE BUILDINGS

EPA's HEADQUARTERS BUILDINGS AT WATERSIDE MALL, WASHINGTON, D.C.

Employees' concerns about the quality of the indoor air at EPA's headquarters at the Waterside Mall began not long after the agency started to occupy the buildings in the early 1970s. Workspace at the Waterside Mall complex became overcrowded as EPA's staffing increased during the next 20 years. As more space was needed, offices were divided and subdivided without commensurate changes in the ventilation system. In some areas, the effectiveness of ventilation air supply or exhaust vents was reduced as walls were constructed to meet the need for additional offices. As a result, employees became increasingly concerned about the poor IAQ.

The General Services Administration (GSA) delegated authority for operating the leased space to EPA in January 1987. In 1988, employees' complaints increased dramatically when EPA began renovating its headquarters' complex to improve working conditions. Soon after EPA started to install partitions and new carpeting and paint the renovated workspace, employees began to complain of headaches, sinus congestion, eye irritation, and fatigue. According to the National Federation of Federal Employees, over 120 people were affected by the poor IAQ and fumes from the new carpeting.[1] Over 40 employees were subsequently relocated to alternative work space, including some who were authorized to work at home. At the time of the complaints, EPA leased about 1 million square feet of space with about 5,000 employees located in that space.[2]

In response to employee complaints, EPA embarked on an extensive program of testing and actions to improve the IAQ and relieve overcrowded conditions. EPA experts and outside consultants performed extensive air monitoring and evaluated the operation of the HVAC system. Initial air testing in 1989 involved tests for 98 chemicals, mostly volatile organic compounds. While these tests did not identify a cause for employees' complaints, they suggested that the furnishings and carpets were emitting small amounts

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[1]According to EPA, during the crisis at the Waterside Mall complex, physician services at the health unit were expanded to provide medical expertise related to indoor air issues.

[2]According to EPA officials, EPA has been reducing the number of employees at the Waterside Mall complex for many years by relocating them to other space in the metropolitan area. Currently, the agency is in the process of consolidating its headquarters' employees into a complex that includes the Ariel Rios and Ronald Reagan Federal Buildings. EPA expects to completely vacate the Waterside Mall complex by 2002.

of chemical gases. Although additional tests were performed on the latex-backed carpeting and the partitions, no significant emissions of 4-phenylcyclohexene,[3] formaldehyde, or other potential indoor air pollutants were found.

With the assistance of the John B. Pierce Foundation of Yale University, EPA and NIOSH began an extensive study of the health and comfort issues at EPA's headquarters at the Waterside Mall complex and two other locations in the Washington, D.C., area. The objectives of the 1989 study were to survey the health symptoms and comfort concerns of employees, evaluate the indoor air environment, and analyze potential relationships between conditions in the building and employees' complaints about their health or comfort. Air monitoring consisted of testing for temperature, relative humidity, carbon dioxide, carbon monoxide, dust levels, formaldehyde, volatile organic compounds, microbiological growth (e.g., bacteria and fungi), pesticides, and aldehydes. Measurements of air flow and other ventilation parameters were also made.

Although the study did not identify specific sources or significant levels of contaminants that could have directly caused the employees' complaints, it did cite several factors that appeared to be associated with them. Dust, water leaks, mold allergens, and the odor of fresh paint and chemicals were all cited as factors potentially affecting employees' health and comfort. While the study noted that the initial widespread reports of health problems followed the installation of carpeting in 1987, it found no causal relationship. The study, however, suggested that improving the airflow, stabilizing the temperatures, and maintaining more comfortable humidity levels would likely help to alleviate the many health and comfort problems employees associated with the hot, stuffy, and dry air in their offices.

OSHA also performed two inspections of EPA's headquarters. The first inspection, carried out in July 1986, found several problems with its heating, ventilation, and air-conditioning system, such as disconnected ducts and fresh air dampers, which were opened at only 20 percent to 25 percent of their design. OSHA made several recommendations, including the repair of the entire ventilation system. By 1990, OSHA decided that it need not continue its involvement in the indoor air issues at the Waterside Mall complex because OSHA believed that EPA had implemented an effective plan that should reduce indoor air problems to acceptable levels.

EPA has made numerous improvements to the ventilation system of the Waterside Mall complex. These improvements included installing supplemental air handlers and air conditioning units as well as more efficient air supply vents; extending exhaust flues to

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[3]According to EPA, no toxicological or health effects have been demonstrated in laboratory tests of 4-phenylcyclohexene.

avoid potential cross contamination with air intakes; reconnecting air ducts; cleaning and balancing the ventilation system; directly venting the copy centers, the janitors' closets, and the printing plant to the outside; and measuring airflow before allowing occupancy of the new space. Also, it contracted with a ventilation engineer to monitor the system, identify potential problems, and recommend corrective actions. In addition, the roofs at the Waterside Mall complex were replaced by the owner to prevent leaks, thus reducing the potential for biological contamination.

EPA has initiated many changes to improve the operation and management of these buildings. In addition to establishing "Operation Clean-up" to mitigate the problems caused by dirt, dust, and allergens, EPA has tried to have maintenance work, such as repairs, renovations, and painting, done at night or on weekends, if the work could adversely affect employees during the day. EPA has also established a Building Services Desk Quality Action Team to improve communications with employees, better respond to their concerns, and record actions taken. Through an interagency agreement, the U.S. Public Health Service now provides EPA Headquarters Safety, Health and Environmental Management staff access to the services of board-certified occupational health physicians and certified industrial hygienists.

EPA was not able to establish a scientific link between the carpets and employees' health problems. However, as a result of a management and union agreement, EPA replaced a certain type of carpeting in the complex. To minimize the chances of problem emissions, new carpets, as well as new furnishings, are now chosen on the basis of low volatility and odor. In addition, EPA purchases only carpeting that uses water-based adhesives, and carpets are aired-out prior to and following installation.

GEORGE H. FALLON FEDERAL BUILDING, BALTIMORE, MARYLAND

Over a period of about 1 week in May 1997, GSA received over 100 health complaints concerning poor IAQ from occupants of the George H. Fallon Federal Building. The complaints, which started on the first floor, soon spread to other floors; eventually, 27 employees were transported to local hospitals for treatment. Although no serious injuries were reported, employees experienced such symptoms as difficulty breathing, stuffy nose, dizziness, headaches, chest tightness, nausea, and eye irritation. According to a physician GSA hired to examine them, a chemical pollutant circulating in the air-handling system was most likely responsible for their symptoms.

GSA manages this 17-story federally owned building, which was constructed in 1967 and has a capacity of 3,500 employees. At the time of the May 1997 incident, occupancy had been reduced to about 700 employees because GSA had begun the first phase of a

$40 million modernization project, which involves completely renovating the building.[4] The renovation includes new mechanical, electrical, and plumbing systems as well new offices and furnishings. Because the renovation work also includes the removal of asbestos, GSA hired an independent contractor to monitor this portion of the work, and all workers are state-certified and licensed.

On the first day employees experienced symptoms, GSA's in-house and contract industrial hygienists inspected the building.[5] The contract industrial hygienist noted that the area on the first floor where the problems had begun lacked adequate ventilation because it was warm even though it was vacant at the time of his inspection. The contractor recommended increasing the ventilation to conform with ASHRAE's standards and testing to measure air quality and ventilation rates. The contractor indicated that chemical contamination did not appear to be the cause of the employees' problems.

GSA also undertook a series of actions to identify the cause of the indoor air problems. To assist in the investigation, GSA retained several contractors, including a ventilation and occupational safety expert as well as a nationally recognized expert in IAQ. Also, OSHA conducted a building occupant IAQ survey.

Although tests did not identify a specific cause for the employees' symptoms, several factors have been identified as potential contributors. The contractor GSA hired to perform a comprehensive assessment of the building concluded that multiple deficiencies in the building's systems in combination with certain external factors were most likely the cause for its indoor air problems. The contractor found such deficiencies as breaches in

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[4]The renovation of the Fallon Federal Building is being completed in stages. According to GSA officials, the first stage, which was completed in December 1997, involved the ninth through the sixteenth floors. Renovation work was conducted on totally vacant floors, with the eighth floor serving as a vacant buffer between the tenants occupying the first through the seventh floors. In December 1997, employees were relocated to the newly renovated space on the tenth through the sixteenth floors, with the ninth floor serving as the buffer floor. Renovation work is now ongoing on the fourth through the eighth floors, which is to be completed by September 1998, and on the buildings plaza. Another renovation is contemplated for the ground through third floor.

[5]In the days following the event, GSA brought in doctors from the Social Security Administration and the Veterans Administration as well as contract physicians and nurses to provide for immediate evaluation of symptoms, including a nurse with specialized certification in occupational health matters. To help employees with long-term health conditions, GSA has retained the services of Johns Hopkins University's Center for Occupational and Environmental Health to evaluate their symptoms and advise them. All medical evaluations are free and confidential.

the building's exterior walls that allowed air from the outside to enter the interior of the building and a general state of disrepair of the building's HVAC system. The contractor stated that these conditions, combined with the asphalt waterproofing repairs being made to the deck of the building's plaza and the roofing repairs being made at an adjacent building may have precipitated the indoor air events that occurred in May 1997.

Although it did not appear that the renovation work on the upper floors contributed to the indoor air problems, GSA took several actions to minimize the potential for problems, including stopping construction work on the upper floors immediately after the incident began. In June 1997, GSA developed interim protocols to monitor the HVAC system's performance, test for indoor air contaminants, establish and monitor barriers to prevent contaminants from infiltrating occupied floors, and prevent water leaks. GSA found that the building was susceptible to the infiltration of contaminants because the air pressure in occupied spaces was not being appropriately maintained and some heating and ventilation dampers and other related controls were not operating as designed. GSA temporarily suspended waterproofing the plaza's deck until additional measures could be undertaken, including fitting the kettle (which is used to heat the waterproofing material) with a system to recover fumes. Prior to allowing employees to reoccupy the renovated space, GSA conducted air-monitoring tests for carbon monoxide, carbon dioxide, formaldehyde, particulates, 4-phenylcyclohexene, and volatile organic compounds. Air temperatures and relative humidity levels were also tested as was the drinking water. The results of all tests were within acceptable ranges.

GSA has also modified building operations. The agency had the building's air circulation system and selected work areas cleaned. Also, GSA suspended the use of most chemical housekeeping products pending review of employees' sensitivities and developed a plan governing their use that included reintroducing all chemicals gradually. To better communicate with employees, GSA has relayed information to them via management, town meetings, small group meetings, and flyers.

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